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## (54) Electrostatic actuator

(57) An electrostatic actuator (10) uses two-dimensional in-plane motion of a monolithic element suspended by flexures which is unstable in the open-loop and uses feedback control to operate. By adding a common bias voltage to each of the stator electrodes (20, 22, 24, 26) when the translator (14) and stator (12) are in the unstable equilibrium position, repulsion can be reduced to zero while the in-plane force remains in unstable equilibrium. Stabilizing the in-plane force at the unstable equilibrium position is achieved by shifting the electrical phase of the stator potential distribution in a direction to produce an in-plane force which opposes motion of the translators away from equilibrium position. Linear control and pulse width modulation control permit altering the phase by less than the stator pitch. The drive electrodes of the translator and stator are used as position sensors for in-plane and out-of-plane relative displacements of the translator and stator concurrent with operation of the motor using either pulse-width modulation or linear control.

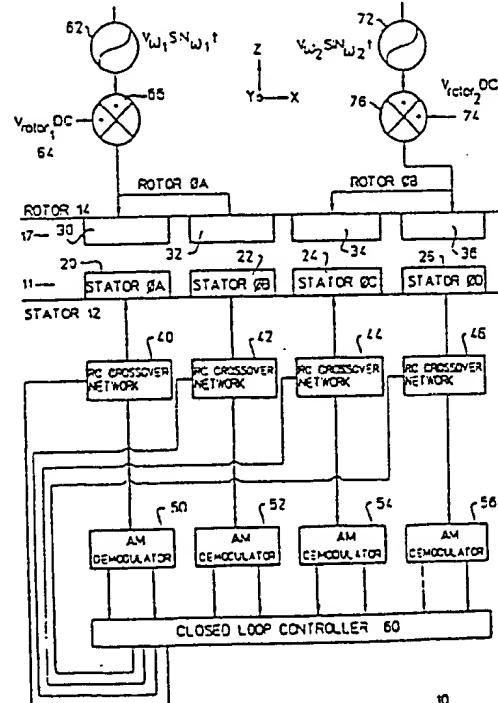


Figure 1



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## EUROPEAN SEARCH REPORT

Application Number  
EP 98 30 8766

| DOCUMENTS CONSIDERED TO BE RELEVANT   |   |  |   |
|---|---|--|---|
| Category  | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim  | CLASSIFICATION OF THE APPLICATION (Int.Cl.) |
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|   |   |  | TECHNICAL FIELDS<br>SEARCHED (Int.Cl.)      |
|   |   |  | H02N  |
| <p>The present search report has been drawn up for all claims</p>   |   |  |   |
| Place of search   | Date of completion of the search  | Examiner   |   |
| THE HAGUE   | 15 February 2000  | Ramos, H   |   |
| CATEGORY OF CITED DOCUMENTS   |   |  |   |
| X : particularly relevant if taken alone<br>Y : particularly relevant if combined with another document of the same category<br>A : technological background<br>O : non-written disclosure<br>P : intermediate document |   | T : theory or principle underlying the invention<br>E : earlier patent document, but published on, or after the filing date<br>D : document cited in the application<br>L : document cited for other reasons<br>S : member of the same patent family, corresponding document |   |

**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 98 30 8766

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